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REMARKS

Claims 1 and 4-17 are all the claims pending in the application. Claims 2-3 have been canceled without prejudice or disclaimer. Claim 17 remains withdrawn from consideration by the Examiner. Reconsideration and allowance of all the claims are respectfully requested in view of the following remarks.

Drawings

The Examiner objected to the drawings as not showing a coned disk spring as set forth in claim 10. Accordingly, Applicants have submitted herewith a new Figs. 23A and 23B which schematically show a coned disk spring. No new matter has been entered.

Claim Rejections - 35 U.S.C. § 102

- The Examiner rejected claims 1-4 under §102(b) as being anticipated by US Patent 5,047,677 to Mineta et al. (hereinafter Mineta). Applicants respectfully traverse this rejection because Mineta fails to disclose all the elements as set forth in the claims.

Claim 1 sets forth a bearing unit comprising a housing, a shaft passing through the housing, and a pair of rolling bearings disposed between the housing and the shaft, at least one of the rolling bearings having an inner ring press-fitted to the shaft, wherein a reduced diameter part having an outer diameter smaller than the inner diameter of the inner ring and a predetermined width in the axial direction is formed on the shaft, wherein a center position of the reduced diameter part of the shaft in the axial direction is substantially set at an intersection position of the inner raceway surface with a contact angle line connecting points that the ball contacts with the inner and outer rings.

For example, as shown in Figs. 1 and 2, one embodiment consistent with that set forth in claim 1 is a bearing unit comprising a housing 29, a shaft 23 passing through the housing, and a pair of rolling bearings 25 disposed between the housing and the shaft, at least one of the rolling bearings 25 having an inner ring 25b press-fitted to the shaft 23, wherein a reduced diameter part 23a having an outer diameter smaller than the inner diameter of the inner ring 25b and a predetermined width D3 in the axial direction is formed on the shaft, wherein a center position C

of the reduced diameter part 23a of the shaft 23 in the axial direction is substantially set at an intersection position O of the inner raceway surface with a contact angle line 28 connecting points that the ball contacts with the inner 25b and outer 25a rings.

With the above arrangement, in rotation drive sections and motors employing the bearing unit, there are eliminated disadvantages resulting from a distortion of the raceway surface 27, caused by increase of a vibration at the time of rotation. Further, the silence performance is improved and the NRRO is reduced.[1]

In contrast to that set forth in claim 1, Mineta discloses a shaft 1a having a reduced section centrally located with respect to the axial ends of the inner rings of bearings 4 and 8. Mineta fails to disclose the contact angle of the bearings and, further, fails to disclose any relationship between that contact angle and the position of the reduced diameter section. Accordingly, Mineta fails to disclose that a center position of a reduced diameter part of a shaft in the axial direction is substantially set at an intersection position of the inner raceway surface with a contact angle line connecting points that the ball contacts with the inner and outer rings, as set forth in claim 1.

For at least any of the above reasons, Mineta fails to anticipate claim 1. Likewise, this reference fails to anticipate dependent claim 4.

Claim Rejections - 35 U.S.C. § 103

- The Examiner rejected claims 5-11 under §103(a) as being unpatentable over Mineta in view of JP 9-88966 (hereinafter JP '966). Applicants respectfully traverse this rejection because the references fail to teach or suggest all the elements as set forth in the claims.

Claim 5 sets forth a bearing unit comprising: sealing plates located at both ends of respective outer rings of a pair of rolling bearings; and spring seats for positioning ends of a compression spring, the spring seats including stepped parts axially formed on the sealing plates, which are located at inner ends of the outer rings opposed to each other.

[1] Specification at page 27, lines 8-24, and page 28, line 18 - page 29, line 3, for example.

For example, as shown in Fig. 6, one embodiment consistent with that set forth in claim 5 is a bearing unit comprising: sealing plates 137 located at both ends of respective outer rings 125a of a pair of rolling bearings 125; and spring seats for positioning ends of a compression spring, the spring seats including stepped parts 137b axially formed on the sealing plates 137, which are located at inner ends of the outer rings opposed to each other.

The Examiner cites JP '966, Fig. 13, as teaching seal plates 7 having stepped parts that are spring seats[2]. The Examiner's interpretation of JP '966 is mistaken.

JP '966 does not teach or suggest a sealing plate having a spring seat formed thereon. Fig. 13 discloses seals 7 having stepped parts, but those stepped parts are not spring seats. That is, a spring seat must have sufficient ability to support a spring under load. Fig. 13 does not show any spring, let alone one that is supported by the seal 7. Thus, seal 7 is only a sealing member; it does not include any structure that would support a spring. Instead, as shown in Fig. 19, JP '966 teaches the use of a separate member as a spring seat; it does not teach seal 7 as a spring seat. Indeed, the spring seat in JP '966 is very much like the spring seats 115, 116 as shown in Fig. 22 of the present specification.

Accordingly, even assuming that one of ordinary skill in the art were motivated to combine Mineta with JP '966 as suggested by the Examiner, any such combination would still not include a sealing plate having a spring seat formed thereon.

Claim 6 sets forth a bearing unit comprising: sealing plates located at both ends of respective outer rings of a pair of rolling bearings; and spring seats for positioning ends of a compression spring, the spring seats including stepped parts formed in inner ends of the outer rings.

For example, as shown in Fig. 6, one embodiment consistent with that set forth in claim 6 is a bearing unit comprising: sealing plates 137 located at both ends of respective outer rings 125a of a pair of rolling bearings 125; and spring seats 139 for positioning ends of a compression

[2] Office Action at page 3, item 6.

spring, the spring seats 139 including stepped parts 139 formed in inner ends of the outer rings 125a.

The Examiner relies on JP '966 as teaching spring seats.[3] The Examiner's reliance on JP '966 is mistaken. As noted above, JP '966 teaches spring seats in Fig. 19, wherein the spring seats are butted against the side of the outer rings 18 of the bearings. Although Fig. 13, as relied upon by the Examiner, shows bearings having outer rings with stepped parts, those stepped parts are not disclosed as being spring seats. Accordingly, JP '966 fails to teach or suggest that the spring seats include stepped parts formed in the outer rings, as set forth in claim 6.

Accordingly, even if one of ordinary skill in the art were motivated to combine the references as suggested by the Examiner, any such combination would still not teach or suggest spring seats that include stepped parts formed in the outer rings, as set forth in claim 6.

Claim 7 sets forth a bearing unit comprising: spring seats attached to a pair of rolling bearings for positioning ends of a compression spring, the spring seats serving as sealing plates for preventing a lubricant filled between the outer ring and inner ring from leaking therefrom, wherein the inner side of the spring seat defines a retainer-interference avoiding clearance for avoiding an interference with the back side of the retainer.

For example, as shown in Fig. 11, one embodiment consistent with that set forth in claim 7 is a bearing unit comprising: spring seats 212 attached to a pair of rolling bearings 202 for positioning ends of a compression spring 220, the spring seats 212 serving as sealing plates for preventing a lubricant filled between the outer ring 203 and inner ring 206 from leaking therefrom, wherein the inner side of the spring seat 212 defines a retainer-interference avoiding clearance 221 for avoiding an interference with the back side 211a of the retainer 211.

[3] Office Action at page 3, item 6.

The Examiner relies on JP '966 as teaching sealing plates 7 including stepped parts and a spring seat having a retainer-interference avoiding clearance.[4] The Examiner's reliance on JP '966 is mistaken.

First, as noted above, sealing plates 7 are not spring seats. Instead, JP '966 teaches the use of a sealing member 7 and a separate spring seat. See Fig. 19.

Second, the sealing members 7 in JP '966 do not include a retainer-interference avoiding clearance. As shown in Fig. 13, as relied upon by the Examiner, seals 7 are positioned on the side of the bearing opposite to that on which the retainer back side extends. That is, in Fig 13, taking the left-side bearing as an example, the seal 7 is on the left side, whereas the retainer back side is on the right side. Accordingly, the seals 7 do not include an retainer-interference avoiding clearance, as set forth in claim 7.

Accordingly, even if one of ordinary skill in the art were motivated to combine Mineta and JP '966 as suggested by the Examiner, any such combination would still not teach or suggest a spring seat that is a sealing member, let alone one that also includes a retainer-interference avoiding clearance, as set forth in claim 7.

For at least any of the above reasons, Mineta and JP '966 fail to render obvious claims 5-7. Likewise, these references fail to render obvious dependent claims 8-11.

- The Examiner rejected claims 12-14, and 16, as being unpatentable over Mineta. Applicants respectfully traverse this rejection because Mineta fails to teach or suggest all the elements as set forth in the claims.

Claim 12 sets forth a rolling bearing unit comprising: a holding member having a first cylindrical peripheral surface; and a plurality of ring members having second and third cylindrical surfaces, wherein said second peripheral surface is interference fitted to the first peripheral surface, and further wherein the interference is set to be 4 μm or smaller, and a run-out of said holding member in the radial direction is set to be 2 μm or less.

[4] Office action at page 3, item 6.

For example, as shown in Fig. 16 one embodiment consistent with that set forth in claim 12 is a rolling bearing unit comprising: a holding member 320 having a first cylindrical peripheral surface; and a plurality of ring members 312, 314 having second and third cylindrical surfaces, wherein said second peripheral surface is interference fitted to the first peripheral surface, and further wherein the interference is set to be 4 μm or smaller, and a run-out of said holding member in the radial direction is set to be 2 μm or less.

Similarly to claim 12, claim 13 sets forth a bearing unit comprising a shaft; and a plurality of rolling bearings held on the shaft with inner rings, wherein the interference between the shaft and the inner rings is set to be 4 μm or smaller, and a run-out of said holding member in the radial direction is set to be 2 μm or less.

Because the interference is set to be 4 μm or less, an appropriate interference fitting can be secured.[5] That is, such an interference allows easy press-fitting, and an adjustment of the bearing position during assembly. During assembly, first, the shaft is coated with adhesive 319, which may be of the slow hardening type. Then, the inner ring 312 of the rolling bearing 311 is press-fitted to the part of the shaft 320 coated with the adhesive 319. In this state, the shaft 320 is rotated to determine run-out. If the run-out is unacceptable (i.e., over 2 μm in this embodiment), then a bending moment is applied to the shaft so as to adjust the position of the bearing with respect to the shaft so as to reduce the residual stress in the fitting faces of the shaft 320 and the inner ring 312.[6]

In the rolling bearing unit 30 thus constructed, the interference is reduced and, hence, the bending of the shaft 320 is also reduced by using the combination of the interference fitting, as set forth in claim 12, and the bonding. Accordingly, the radial run-out of the shaft is reduced. Since the interference is small, i.e., less than 4 μm, the work to fit the inner rings 312 to the shaft

[5] Specification at page 61, 2nd full paragraph.

[6] Specification at page 61, line 15 - page 62, line 20.

320 is easily performed and, in turn, allows the radial run-out of the shaft to be adjusted during assembly.[7]

In contrast to that set forth in claim 12, Mineta fails to teach or suggest any particular value of the interference between the shaft 1a and the inner rings of bearings 4, 8. The Examiner asserts that it would have been obvious to minimize the "clearance and run-out of the bearing assembly, as it is old and well known in the art that these specifications must be minimized in order to reduce vibration and increase the efficiency of a bearing."[8]

However, although radial run-out may be related to vibration and efficiency of a bearing, it is not well known that the amount of interference between the shaft and the inner ring of a bearing is so related. Instead, it is Applicants who have discovered that using a particular amount of interference allows the parts to be adjusted during assembly so that run-out can be minimized. Thus, one of ordinary skill in the art would not have been taught or suggested to use Applicants' claimed value of interference, in order to reduce radial run-out, or vibration in a bearing.

For at least any of the above reasons, Mineta fails to render obvious claims 12 and 13. Likewise, this reference fails to render obvious dependent claims 14 and 16.

Conclusion

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

[7] Specification at paragraph bridging pages 62 and 63.

[8] Office Action at page 4, item 7, paragraph 2.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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